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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Paper No. 11123

Application Number: 09/440,794
Filing Date: November 15, 1999
Appellant(s): BAILEY III ET AL.

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Ramin Mahboubian
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 9/22/2003.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Invention

The summary of invention contained in the brief is correct.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

The rejection of claims 31-45 and 49-56 stand or fall together because appellant's brief does not include a statement that this grouping of claims does not stand or fall together and reasons in support thereof. See 37 CFR 1.192(c)(7).

(8) Claims Appealed

A substantially correct copy of appealed claims 31-45 and 49-56 appears on pages 19-23 of the Appendix to the appellant's brief. The minor errors are as follows:

Claim 31's last word was changed from "direction" to "substrate" in Final Rejection of 4/9/2003 according to an examiner's amendment authorized by R. Mahboubian.

(9) Prior Art of Record

6,085,688	Lymberopoulos et al.	7/2000
6,217,786 B1	Hills et al.	4/2001
6,254,966 B1	Kondo	7/2001
EP 0821397 A2	Lu et al.	1/1998

(10) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 31-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lymberopoulos et al.(US 6,085,688) in view of Hills et al. (US 6,217,786 B1).

Lymberopoulos et al. discloses a method of and apparatus for producing a plasma for use in manufacturing microelectronics including dry (i.e. gas phase) etching of semiconductor wafers. The chamber shown in Fig 5 is azimuthally symmetric around

the center. The chamber holds the plasma as it is ignited and during the processing of the wafer since there is no separate plasma generation chamber. A window is disclosed in column 6 lines 8-35. The Rf antenna (i.e. a coil is shown in Fig. 5 as 110) is disposed above the plane defined by the wafer (i.e. substrate). Electromagnets (150a and 150B in Fig. 5) are disposed above the wafer. The magnets are disclosed as independently controllable conductors in the abstract and are used to control the plasma density and prevent non-uniform charge build-ups. By magnetically controlling the uniformity of charge distribution, one of ordinary skill in the art would expect the uniformity of the etching to be controlled. This reads on the changing of the variation in the magnetic field to improve processing uniformity across the substrate. The wafer is placed in the chuck at the bottom of the reaction chamber and gas is flowed in to form a plasma. In col. 10 lines 1-8, the control of the plasma density throughout the chamber from the workpiece to the inductive window and antenna is suggested. The relationship of the magnetic fields to the plane of the substrate to be etched is shown in the Figs. including that numbered 11. Clearly the magnetic field need not be perpendicular to the substrate surface. In col. 7 lines 24-31 is described the control of the magnetic field to directly control the plasma density near the workpiece surface.

Lymberopoulos does not explicitly disclose dc power to the electromagnets but dc is a known power supply configuration. Lymberopoulos is silent as to the gas used in the etching process.

Hills et al. discloses etching a wafer and an oxide on that wafer using specified gases including fluorocarbons and inert carrier gases with Rf plasma (a dry etching

process). The specific fluorocarbons of C2F6, C3F6 and C4F8 or mixtures thereof were disclosed as were the carrier gases of Ar, He, Ne, Kr, Xe, or mixtures thereof. These read on the two or more gases of the form CxFyHzOw as defined in the spec lines 19-21 on page 30). Oxygen and nitrogen gases as well as the hydrogen-containing additive gases CH4, H2, H2O, NH3 were also optionally present.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine the method disclosure of Lymberopoulos et al. with that of Hills et al. because Lymberopoulos et al. discloses a Rf powered plasma etch process and chamber and Hills et al. discloses a etching gas useable in a Rf powered plasma processing chamber.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to, in a chamber configured as disclosed in claim 31, to control the magnetic field in the region proximate the antenna to improve the processing uniformity across the substrate because Lymberopoulos et al. discloses such magnetic control in an etching process and such control would have been anticipated to produce an expected result of process uniformity.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to flow the claimed listed gases into such an Rf plasma processing chamber because these gases were known to Hills et al. for Rf processing and their use would have been anticipated to produce the expected result of dry plasma etching.

3. Claims 36-41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lymberopoulos et al. and Hills et al. as applied to claims 31-35 above, and further in view of Kondo (US 6,254,966).

Lymberopoulos et al. and Hills et al. are described above.

Kondo et al. discloses a supporter for recording mediums which is made of (see col. 17 lines 55+) glass (a.k.a. amorphous silicon dioxide). The etching of the supporter is performed by dry etching. Plasma is known to those of ordinary skill as a dry etching process since gases are used to form the excited species therein. The gases used to etch include CHF_3, CF_4, C_2F_6, C_3F_8, NF_3, SF_6, C_2F_4, C_3F_6, C_4C_8, C_4F_{10}, C_5F_8, C_6F_{14}, C_3F_6O, C_9F_{10}, CF_3Br, CF_3I, C_2F_5I, CF_2Cl_2, $CFCl_3$, CH_2F_2, C_2HF_5, $C_2H_2F_4$, $C_2H_4F_2$, $C_2H_3F_3$, C_3HF^7, CF_3, $C_2H_2F_3$, $C_8H_3F_5$, Cl_2, CCl_4, $SiCl_4$, BCl_3, PCl_3, CCl_3F, BBr_3, CH_2Cl_2, and mixed gases thereof and other mixed gases containing oxygen, hydrogen, argon, He, N_2, Ne, Ar, Kr, Xe, O_3, CO, CO_2, H_2O, CH_4, C_2H_6, C_3H_8, C_4H_{10}, C_2H_4, C_3H_6, C_4H_8, C_2H_2, and C_3H_4.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine Kondo et al. with the previous cited references because Kondo et al. provides a more complete discussion of the gases used in plasma (i.e. dry etching) applications for etching silicon oxide.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the claimed listed gases in a plasma etching process because the claimed listed gases were known for plasma etching and their use in such an environment would have been anticipated to produce an expected result.

4. Claims 42-45, 49-53, 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lymberopoulos et al. and Hills et al. as applied to claims 31-35 above, and further in view of Lu (EP 0821397 A2).

Lu et al. discloses a composite SiC that is used to form the chamber wall, chamber roof, collar around the wafer, grounding plane, and window for Rf radiation. The SiC is described as useful for reducing flaking (page 6 lines 35+). The surface after etching was smooth. This suggests little interaction of the material and the plasma. And, as table 2 shows, the etch rate of the SiC was less than the commonly used quartz or Si. The SiC was described as made from a layer of CVD SiC composite bonded to a free standing SiC wall formed from such methods as sintering or hot pressing. The bulk wall was described as grounding in 40-45.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to form the processing chamber form a material such as a composite SiC that does not substantially react with the reactive gases flown into the processing chamber and forms a ground because such a SiC chamber is suggested by Lu et al. and that such a material was not substantially reactive with Rf plasmas. The examiner notes this reads on a chamber made entirely of SiC since Lu et al discloses walls roof and Rf window made of SiC. Additionally, the examiner argues that the apparatus limitations do not affect the process in a manipulative sense and therefore do not have weight in the process claims. There is not a manipulative effect since SiC walls are taught by Lu et al. and one of ordinary skill would expect this material to react to the same plasma conditions in a similarly.

Claim Rejections - 35 USC § 112

5. Claim 31 is rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The specification does not supply support for the newly added limitation "...wherein said different radial locations include at least one radial region which is not in an axial direction perpendicular to said substrate." The appellant has not specified where support for this negative limitation is found.

(11) Response to Argument

The argument of point B. on page 7 of the Brief is not convincing. The reading in the first paragraph as to what is suggested by claim 31 is agreeable. However, the examiner must point to the last two sentences of Lymberopoulos's abstract to find suggestion. The further feature there described provides "independently controllable conductors for generating the magnetic field" and provides "an adjustable non-uniformly distributed magnetic field within the chamber." It is further described as allowing selective control of the plasma density and selective confinement of process gas species. The examiner submits that the non-uniform magnetic field within the chamber certainly suggests a radial variation in it.

The argument of the second paragraph on page 7 is also refuted by these sentences since "the process gas species can be selectively confined." Also, Fig. 11 shows that the different radial locations (as measured parallel along the surface of the substrate include at least one radial region that is not in an axial direction perpendicular to the substrate. The field lines (146) clearly are not perpendicular to the substrate in all radial locations as the bend out toward the walls as they approach the substrate.

The argument that Lymberopoulos et al. only deals with charge build up is not convincing. The appellant is trying to divert attention form the abstract's last two sentences. Avoiding charge buildup is one way to operate such RF plasma machines as is having a non-uniform magnetic field in the chamber to control plasma density and, in turn, etching. The appellant wants us to ignore that control of plasma density with such a RF plasma setup was known at least to Lymberopoulos et al.

The teaching away argument on page 9 last paragraph is not persuasive. In fact, Fig. 11 of the patent only has one set of magnetic field lines drawn in. Any number of lines indicating the location of equivalent magnetic field strength can be drawn into the picture of Fig. 11. Appellant's Fig. 2A has more drawn in and at least one set of lines match up with those of Fig. 11 in the patent. Considering that the apparatus configurations used in the patented method (see Fig. 5 of the patent with a top RF array denoted 110 and side wall magnets denoted 150 a and 150b) and the current application (Fig 1 of the application with RF array 102 and pairs of magnets 132) are similar, similar results would be expected. Lymberopoulos points to Fig. 11 as an

example of non-uniform magnetic field within the chamber which in turn controls the plasma density within the chamber.

Hills et al. is attacked on page 10 for unconvincing reasons. First the examiner notes here that the rejections were based on a combination of the references. Second, the Hills reference does indeed teach two or more $C_xF_yH_zO_w$ gases. C_nF_m is a $C_xF_yH_zO_w$ gas where x=n, y=m, z=0, and w=0. O_2 is a $C_xF_yH_zO_w$ gas with w=2 and x, y, and z equal zero. See col. 4 lines 55-60 which indicate the fluorocarbon of Hills can be a mixture. In other words, two or more fluorocarbons can be used in the etchant gas. Also, inert gas such as the commonly known noble gases (He, Ne, Ar, Kr, Xe) ,as well as O_2 and N_2 can be included.

The arguments of point D. beginning on page 12 are not convincing.

The combined Lymberopoulos et al. and Hills et al. references suggest control of a magnetic field above the substrate in RF plasma etching and known gas chemistries for RF plasma etching. Hills et al. suggests using the gases for critical dimension control (col. 3 lines 35-41). Lymberopoulos et al. controls plasma density near the wall and near the substrate (col.10 lines 10-21). Lymberopoulos et al. further suggests optimization of the process in col. 10 lines 20-27. The parameters such as plasma ion density is said in col. 1 lines 1-16 to affect the rate and the quality of etching. One of ordinary skill would expect a uniform plasma density at the substrate to etch that substrate uniformly. The appellant seems to suggest that the prior art had no concept that improved uniform etching of the substrate was preferred. Hills et al. suggests critical dimension control in a plasma process which suggests to one of ordinary skill

uniform processing. Non-uniformity in integrated circuits is commonly known to be not in any way desired.

Motivation for combination was presented by the examiner previously (see page 4 of the Final Rejection paper #18). Improving process uniformity is basic to making uniformly acting integrated circuits and devices which use them. Hills et al. suggests critical dimension control of trenches etched on a substrate. The examiner cannot over emphasize the conventionality of improving process uniformity especially in semiconducting substrate etching.

The arguments of point E. on page 14 are not convincing.

The Kondo et al. reference suggests other known gas chemistries used in dry etching substrates. The examiner has provided a reason for combination and notes that the reference is part of a combination which at least suggests magnetic field control and uniform substrate etching. The gases were known to etch substrates and magnetic field control for plasma density control was known.

The arguments of point F on page 16 are not convincing.

Lymberopoulos suggests lowering the density near the walls to reduce damage there col. 2 lines 30-35. Lu et al. suggests the SiC components for RF plasma etching reactors which react little with the plasma gases as compared to the materials etched in the chamber. In combination, one of ordinary skill would use SiC because it was known to work for RF etching chamber components in the past.

The arguments of Point G on page 17 are persuasive.

The examiner, however, observes that this radial variation supported in Fig. 2A (see page 18 first paragraph of the Brief) confirms the examiner's take on the radial variation found in Fig. 11 of Lymberopoulos et al. The non-uniform magnetic field of Lymberopoulos et al. must have at least one such area or region with non-perpendicular (to the substrate) magnetic fields not in an axial direction perpendicular to the substrate since it matches that found in the present invention.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

MAA
November 17, 2003

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